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Report

The impact of revising fats and oils data in the US Food and Nutrient Database for Dietary Studies

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ABSTRACT

Major changes occurred in the fats and oils data for foods in the USDA National Nutrient Database for Standard Reference (SR), Releases 17, 18, and 20. New items were added and values for existing items updated. These data were incorporated into the Food and Nutrient Database for Dietary Studies (FNDDS), Releases 2.0 and 3.0 through cooperation between the Food Surveys Research Group (FSRG), where the FNDDS is prepared for the analysis of *What We Eat in America* (WWEIA), the dietary interview component of the National Health and Nutrition Examination Survey (NHANES), and the Nutrient Data Laboratory (NDL), where SR is produced and which serves as the basis for the nutrient values in FNDDS. The task of updating the FNDDS requires synergistic efforts by specialists at both NDL and FSRG as well as extensive communication with industry. To determine the changes needed in FNDDS, recipes and ingredient lists were reviewed for the types of fats/oils used for several food categories. The types of fats/oils in commercially prepared foods such as crackers and in home/restaurant-prepared food such as fried fish were updated based on product formulation changes, availability of data in SR, and review of information from industry and the WWEIA, NHANES. Also, updated nutrient values from SR for existing fats/oils were incorporated into the FNDDS. Using national data from the WWEIA, NHANES 2001–2004, the impact of these changes on daily intake estimates of energy, total fat and fatty acids was determined. These changes resulted in minor but statistically significant ($p < 0.001$) differences in mean intakes for the majority of the nutrients.

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1. Introduction

Food composition databases are essential for the analysis of dietary intake data to derive caloric and nutrient intake estimates for population groups. The validity of the dietary intake estimates is dependent on the quality of the Food and Nutrient Database used (Burlingame, 2003; Leclercq et al., 2001). To ensure that food consumption analyses are meaningful, the database must be continually updated to reflect changes in the food supply and improvements in the estimation of nutrient composition. There have been tremendous changes in the US food supply with respect to fats and oils. Significant efforts have been made in recent years by food manufacturers, food service establishments, the oilseed industry, and oil processors to reduce or eliminate partially hydrogenated fats/oils (Borra et al., 2007; Eckel et al., 2007; Tarrago-Trani et al., 2006). These rapid changes in the marketplace pose challenges in keeping fats and oils data in nutrient databases current with the marketplace (Kris-Etherton and Etherton, 2003).

The United States Department of Agriculture (USDA) Food and Nutrient Database for Dietary Studies (FNDDS) is a database of foods, their nutrient values, and weights for typical food portions consumed by the US population (US Department of Agriculture, Agricultural Research Service, 2008). Its main purpose is to code foods and amounts and determine nutrient intakes for participants in *What We Eat in America* (WWEIA), the dietary interview component of the National Health and Nutrition Examination Survey (NHANES), and is based on the USDA National Nutrient Database for Standard Reference (SR). This paper describes the changes made in the fats and oils data in the FNDDS, and evaluates the impact of these changes on the national intake estimates in the US.

1.1. Overview of the USDA's Food and Nutrient Database for Dietary Studies

The FNDDS contains information for about 7000 foods as they are consumed by the US population, including values for food energy and 63 nutrients, as well as weights for common food

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portions. It is maintained by the Food Surveys Research Group (FSRG) in the Beltsville Human Nutrition Research Center of USDA's Agricultural Research Service. Versions of the FNDDS correspond to releases of the data from *What We Eat in America*, NHANES, i.e. FNDDS 1.0 was used for survey data collected in 2001–2002, FNDDS 2.0 for 2003–2004, and so on (Bodner-Montville et al., 2006).

Nutrient values in the FNDDS are based on the USDA National Nutrient Database for Standard Reference maintained by the Nutrient Data Laboratory (NDL), also at the Beltsville Human Nutrition Research Center (US Department of Agriculture, Agricultural Research Service, 2007). FNDDS 1.0 was based on SR, Release 16.1, whereas FNDDS 3.0 was based on SR, Release 20. About a third of the foods in the FNDDS are direct links with SR items. For example, raw apple or cheese puffs in FNDDS are linked in a 1:1 ratio to raw apple or cheese puffs in SR, respectively. Direct links to SR analytical data are used whenever available. The other items in the FNDDS are multi-ingredient foods for which the nutrients are derived by recipe calculations using data from SR for ingredients. Some multi-ingredient foods calculated by recipe are commercial foods reported by survey respondents, but unavailable in SR (e.g. some specific kind of crackers or ice cream). The majority of the multi-ingredient foods are mainly home or restaurant-prepared foods. For example, the nutrient values in FNDDS for "Red kidney beans, dry, fat added in cooking" are calculated using data for three SR items – red kidney beans, vegetable oil composite, and salt. The vegetable oil composite is linked to multiple SR codes (soybean oil, canola oil, corn oil, and olive oil). It is used to determine nutrient values when the respondent is unable to identify the type of fat used in cooking. The FNDDS–SR links file (part of the FNDDS) documents the links between the FNDDS and SR.

1.2. Overview of changes made in the FNDDS for fats and oils data

Major changes occurred in the fats and oils data in SR, Releases 17, 18, and 20, reflecting major industry changes. Twenty-one industrial oils and six industrial margarines and shortenings designed for use in commercial food products were added in Release 17. These industrial products were described in SR by oil source (soy, canola, etc.), hydrogenation, and principal uses of the product (frying, salad, confection, etc.). For Release 18 the fatty acid contents of multi-ingredient commercial foods in SR were updated to use new data on industrial fats and oils, replacing data on retail fats and oils previously used in ARS formulation estimations for these commercial foods. For example, for cheese puffs the fat/oil ingredient was changed from a composite of corn oil, partially hydrogenated soybean oil, and cottonseed oil to a composite of corn oil and industrial mid-oleic sunflower oil. For Release 20, the data for margarines and spreads were updated to reflect major industry changes in oil ingredients (US Department of Agriculture, Agricultural Research Service, 2004, 2005, 2008).

In addition, improved food composition values generated by the National Food and Nutrient Analysis Program (NFNAP) were incorporated into SR. NFNAP was designed to generate improved and nationally representative nutrient estimates of foods identified as contributing the most to 75% of the consumption of any nutrient, through a variety of means including the development of statistically based sampling plans, the use of comprehensive quality control measures, and the qualification of analytical laboratories for USDA-supervised nutrient analyses (Haytowitz et al., 2008).

To determine changes needed in FNDDS to incorporate these new and updated data from SR, recipes and ingredient lists were reviewed for the types of fats/oils used. The changes made in FNDDS, 2.0 and 3.0 over a 4-year period are discussed below:

- Nutrient values of foods in the FNDDS linked in a 1:1 ratio were updated with new SR data. These updates included new analytical data for foods such as retail margarines and spreads, and updated data for multi-ingredient commercial foods in SR such as cheese puffs and pretzels, many of which have been reformulated by food manufacturers to be able to achieve a label claim of *trans*-fat free.
- Next, fats/oils used to calculate nutrient values for multi-ingredient food items in the FNDDS–SR links file were systematically reviewed over a 4-year period. Every food item with a fat/oil ingredient reported 10 times or more in the latest national dietary survey was identified and categorized into one of over 90 food groups. Information was then collected about current trends in the marketplace. Multiple sources including data from major fast food chains, manufacturers, literature, and trade organizations were used. In addition, responses from WWEIA, NHANES questions as to where the food was obtained, and modifications made to the foods based on type of fat used for cooking by survey respondents were reviewed. As a result, changes in the fats/oils ingredients were made for about 750 food items. Table 1 lists selected changes for these foods between FNDDS 1.0 and FNDDS 3.0. For example, the default fat used to calculate nutrient values for cooked vegetables was changed from margarine with 80% fat level to a margarine-like spread with 60% fat, as market data show that 60% fat is the predominant level for margarine-like products in the US. For the group "Fried fish and seafood", review of WWEIA, NHANES responses showed that the majority of the survey respondents obtained these food items from restaurants and fast food establishments. Survey respondents obtaining their food from these sources are more likely to be unable to identify the type of fat used in cooking. As a result, the default fat used to calculate nutrient values for 72 fried fish and seafood items was changed from a household shortening to an industrial shortening. For the group "Fried vegetables", the default fat was changed from a vegetable oil composite to an industrial shortening if the

Table 1
Selected changes in fats/oils ingredients in FNDDS–SR links file.

	FNDDS 1.0	FNDDS 3.0
Beans, fat added in cooking	Animal fat	Vegetable oil composite
Fish and seafood, fried	Household shortening	Industrial shortening for frying (partially hydrogenated soybean oil and corn oil)
Pizza with meat toppings	Soybean oil	Composite of soybean oil, partially hydrogenated soybean oil, and corn oil
Potatoes, stuffed and baked or mashed	Margarine, 80% fat	Table fat composite (margarine and butter)
Selected commercial products (ice cream sandwich, selected cookies and crackers)	Hydrogenated soybean oil	Partially hydrogenated industrial soybean oil
Vegetables, fat added in cooking (exclude fried)	Margarine, 80% fat	Spread, 60% fat
Vegetables, fried	Vegetable oil composite	Industrial shortening for frying (partially hydrogenated soybean oil and corn oil) or soybean and canola oil

vegetables (e.g. fried mushrooms) were obtained more from outside home, or to a composite oil consisting of soybean and canola oil for fried vegetables traditionally home prepared (e.g. fried plantains).
- Fat/oil ingredients for many other multi-ingredient foods were not changed; however, the current SR data were used to update the existing fat/oil ingredients. For example, the nutrient profile of corn oil was updated in SR to include new analytical data and to include data for industrial as well as retail oil. When these new data were incorporated into the FNDDS, the nutrient profile changed for more than 200 foods using either corn oil or vegetable oil composite (of which corn oil is a component) as an ingredient.

These updated data were incorporated into the FNDDS through close cooperation between FSRG, where the FNDDS is prepared for the analysis of the WWEIA, NHANES and the NDL, where SR is produced. Changes to major groups were made after joint consultations between nutritionists in both groups, as well as extensive communication with industry.

2. Methods: impact of changes in the FNDDS fats/oils on national intake estimates in the US

Using national dietary intake data from the WWEIA, NHANES 2001–2004, the impact of these changes on daily nutrient intake estimates was determined. The dietary intake data were analyzed with FNDDS 1.0 and then re-analyzed with FNDDS 3.0 to adjust for changes in fats/oils in the FNDDS, and the differences in intake estimates were examined.

Twenty-four hour recalls from a nationally representative sample of 18,594 individuals of all ages (excluding breast-fed children) from WWEIA, NHANES 2001–2004 were used for this study. NHANES is the major national survey in the United States, designed to assess the health and nutritional status of adults and children. *What We Eat in America* is the dietary interview component of NHANES, conducted as a partnership between the USDA and Department of Health and Human Services (DHHS). A nationally representative sample of about 5000 individuals is examined each year. The design and methodology of the survey are detailed elsewhere (United States Department of Health and Human Services, National Center for Health Statistics, 2006). Two consecutive data releases, NHANES 2001–2002 and NHANES 2003–2004, were used to provide as large a sample size as feasible for this project.

Foods and beverages consumed by the survey participants were matched to items in FNDDS 1.0 and assigned the corresponding nutrient values. Nutrient values in FNDDS 1.0 were based on SR, Release 16.1 (US Department of Agriculture, Agricultural Research Service, 2004). Default recipes used to calculate the nutrient content of mixtures were used. Recipe modifications used in the original analysis of the survey to match respondents' own recipes more closely were not used in this study because prior research has shown that the modifications did not have any significant effect on nutrient intakes (Ahuja et al., 1999). Mean intakes were estimated for energy, total fat, and total and individual fatty acids. The impact on *trans*-fatty acid intakes could not be studied, as *cis* and *trans* configurations of the fatty acids are not differentiated in the FNDDS. The mean percent contributions to energy from total fat, saturated fat, monounsaturated fat, and polyunsaturated fat were also determined. The results were weighted to produce national probability estimates for the US population using SAS 9.1 (SAS, Cary NC) and SUDAAN (Research Triangle Institute, Research Triangle Park, NC). The dietary intake information was then re-analyzed with FNDDS 3.0. Nutrient values in FNDDS 3.0 are based on SR, Release 20 (US Department of Agriculture, Agricultural Research Service, 2007). Mean differences and percent differences were determined, and tested for significance by the two-tailed Student *t*-test ($p < 0.001$). The significance criterion $p < 0.001$ was chosen to balance the relatively large sample size available from the WWEIA, NHANES 2001–2004.

The differences in the daily intake estimates of total fat and fatty acids represent the impact of changes in the nutrient values in the FNDDS, Versions 1.0 and 3.0, and serve as a proxy for changes in fats and oils data. The majority of the changes between the two versions with possible impact on the intake of total fat and fatty acids were the result of changes discussed above. Other changes with possible impact on intake of total fat and fatty acids include increased use of low fat beef cuts, ground beef, and ham products as ingredients. Isolating the impact of changes in fats and oil ingredients is not logistically possible, as some highly consumed multi-ingredient foods including cheese pizza, cheese puffs, and potato chips are directly linked to analytical data in SR. The differences in estimated intakes presented here do not represent trends in nutrient intakes. For analyses of temporal trends in nutrient intakes, changes in food consumption over a period need to be considered. In addition, the earlier nutrient intake estimates will need to be adjusted for data improvements to improve comparability with more current intakes.

3. Results and discussion

Mean weighted estimates of daily intakes of energy, total fat, and fatty acids, calculated using FNDDS 1.0 and FNDDS 3.0, are presented for all individuals in Table 2. The difference between the two values, the significance of the difference, and the percent difference are also given. For most nutrients, the changes in fats/oils data resulted in minor, but statistically significant differences in mean intake estimates. These differences though statistically significant, may not be practically important for some nutrients given the large sample size. The statistics provided in Table 2 allow the reader to make such a determination. Differences in the intake estimates for food energy were less than 1%, whereas a difference of −2.3% was seen for total fat. Among the fatty acid classes, no significant difference was seen for saturated fat, but significant differences were seen for monounsaturated fat (−3.4%), and polyunsaturated fat (2.7%). Significant differences were seen for mean percent contribution of the fatty acid classes to total energy intake, with a relative difference of −1.2% for total monounsaturated fatty acids and 1.8% for total polyunsaturated fatty acids. For the nineteen individual fatty acids analyzed, the percent difference between the intake estimates determined ranged from −6.1 to 5, except for the monounsaturated fatty acid gadoleic acid (20:1) for which the relative difference was 11%. Small relative differences were seen in the intake estimates for the major fatty acids – oleic (18:1), palmitic (16:0), and linoleic (18:2).

The differences in the intake estimates reflect data improvements as well as changes in the food supply. Improved nutrient values may be due to recent and nationally representative nutrient estimates of foods generated by NFNAP, or better analytic capabilities. For example, the review of food groups contributing to the difference in the intake estimates for total fat indicates that the differences may have been due to improved data for foods such as fried potato items, peanut butter, and chicken. These foods are among the top contributors to fat in the diets of adult Americans Moshfegh and Goldman (personal communication). The differences seen for fatty acids which are present in small amounts such as gadoleic acid (20:1) may be due to improvements in fatty acid analysis methodology that can detect amounts that were previously undetectable. While it is hard to pinpoint market trends which led to specific changes in the nutrient intake estimates due to number of foods and multiple factors involved,

Table 2
Comparison of mean nutrient intake estimates based on FNDDS 1.0 and FNDDS 3.0[a].

Nutrients (unit)	FNDDS 1.0		FNDDS 3.0		Difference[b]	%Difference
	Mean	S.E.	Mean	S.E.		
Food energy (kcal)	2166	11.7	2156	11.9	−10.10*	−0.5
Total fat (g)	81.9	0.58	80.1	0.53	−1.85*	−2.3
Saturated fatty acids (g)	27.0	0.21	27	0.20	0.07	0.2
Monounsaturated fatty acids (g)	30.6	0.22	29.5	0.21	−1.04*	−3.4
Polyunsaturated fatty acids (g)	16.3	0.16	16.7	0.16	0.43*	2.7
Individual fatty acids						
4:0 (g)	0.58	0.009	0.59	0.009	0.012*	2.1
6:0 (g)	0.31	0.005	0.32	0.005	0.010*	3.1
8:0 (g)	0.26	0.003	0.27	0.003	0.013*	5.0
10:0 (g)	0.45	0.006	0.46	0.005	0.012*	2.6
12:0 (g)	0.76	0.013	0.80	0.014	0.038*	5.0
14:0 (g)	2.3	0.027	2.29	0.025	−0.006	−0.3
16:0 (g)	14.55	0.110	14.44	0.106	−0.107*	−0.7
18:0 (g)	6.96	0.057	7.03	0.055	0.074*	1.1
16:1 (g)	1.27	0.010	1.2	0.009	−0.078*	−6.1
18:1 (g)	28.59	0.212	27.60	0.199	−0.990*	−3.5
20:1 (g)	0.21	0.005	0.23	0.005	0.023*	11.0
22:1 (g)	0.04	0.008	0.04	0.008	#	#
18:2 (g)	14.34	0.142	14.87	0.143	0.522*	3.6
18:3 (g)	1.44	0.014	1.43	0.014	−0.007	−0.5
18:4 (g)	#	#	0.01	0.000	#*	#
20:4 (g)	0.12	0.002	0.12	0.002	#	#
20:5 (g)	0.03	0.002	0.03	0.002	#*	3.9
22:5 (g)	0.01	0.001	0.01	0.001	#	#
22.6 (g)	0.06	0.003	0.07	0.003	#	#
Mean percent contribution to energy						
Total fat (%)	33.0	0.17	33.0	0.17	0.01	#
Saturated fat (%)	11.1	0.08	11.1	0.08	0.03*	0.2
Monounsaturated fat (%)	12.3	0.07	12.1	0.07	−0.15*	−1.2
Polyunsaturated fat (%)	6.8	0.05	6.9	0.05	0.12*	1.8

# Indicates a non-zero difference too small to display.
[a] Twenty-four hour dietary recalls from *What We Eat in America*, National Health and Nutrition Examination Survey (NHANES) 2001–2004, Day 1, $N = 18{,}594$, excludes breast-fed children.
[b] Differences are based on values before rounding.
* Indicates a significant difference at $p < 0.001$.

some of these changes in the US food supply may include reformulation of commercial products by food manufacturers to achieve a label claim of *trans*-fat free, greater availability of lower fat products such as 60% margarine-like spreads, partial displacement of soybean oil with other oils in product reformulations, decreasing trend toward use of animal fats such as lard, and increased reporting of foods eaten outside home. These trends are reflected in the updated values in the database for foods such as margarine and margarine-like spreads, tortilla chips, cheese puffs, cooked vegetables and beans, and fried fish and seafood. In general, the assessment of intake of total fat and fatty acids based on self-reporting has certain inherent limitations. The respondents who do not prepare their own food may be unable to identify the type and amount of fat used in food preparation. Fats used in many commercial foods such as margarine, baked products etc may change based on current market prices, affecting their fatty acids composition and are very brand specific (Cantwell, 2000). Rapid changes in the fast food and commercial food marketplace with respect to type and amount of fat used pose additional challenges.

4. Conclusion

Maintaining nutrient databases and, fats and oils data, in particular in the constantly changing US food supply, is a challenging task achieved through multifaceted efforts by ARS specialists at Nutrient Data Laboratory and Food Surveys Research Group. These changes, both in formulation changes and improved or more recent data, resulted in minor but significant changes in intakes for majority of the reported nutrients.

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